Abstract

Novel hybrid membranes were prepared for post-combustion CO2 capture applications. Functional nanoparticles (FunzioNano®) were incorporated in PPO-supported PVA asymmetric membranes to increase both CO2 permeance and CO2/N2 separation factor. Membranes were tested at varying CO2 content between 5 and 20% and feed pressures between 1 and 6 bars. The addition of FunzioNano® resulted in an increase in permeance between to 0.24-0.43 m³·m⁻²·h⁻¹·bar⁻¹ and CO2/N2 separation factor between 43-79. Hybrid membranes incorporating these materials have previously shown CO2 permeance of 1 m³(STP)/(m²·h·bar) at CO2/N2 selectivity >100. The FunzioNano® nanoparticles were prepared by SINTEF Materials and Chemistry, and the hybrid membranes in the Memfo-group at NTNU.

Introduction

Hybrid membranes (Fig.1), integrating hybrid nanosized functional particles in the polymer matrix, benefit of both polymeric and inorganic materials and have become a focus for the next-generation gas separation membranes. Membranes incorporating FunzioNano®, a class of highly branched nanosized polymers (Polyhedral Oligomeric SiLsesquioxanes, POSS®), have previously shown a performance above the Robeson plot upper bound (Fig.2).

In HyMemCOPI we aim to investigate in depth the various parameters and variables which may influence the preparation of these hybrid membranes, which will enable improved membrane design and fabrication, and finally more efficient and robust membranes.

Experimental

With the aim to gain understanding of the transport phenomena in these hybrid membrane materials the following work is conducted:

- Membrane fabrication with and without the addition of the FunzioNano® particles
- Membrane type: 4-5 micron-thick PVA layer supported by PPO hollow fibre
- Gas permeation measurements: CO2 content between 5 - 20% and feed pressures 1 - 6 bars.

Results

In figure 5 and figure 6 a decreasing CO2 permeance is observed with increasing CO2 content in feed. CO2 permeance is between 0.24-0.43 m³·m⁻²·h⁻¹·bar⁻¹ and CO2 selectivity varies between 43-79. As can be seen, incorporation of FunzioNano® results in a large increase in CO2 permeance, however, combined with a somewhat lower CO2/N2 separation factor.

Conclusions

These initial results show that there are discrepancies between previously obtained results, and that the combined increase in permeance and separation factor is not obtained. It is thus necessary to:

- Study in depth the various parameters and variables which may influence the preparation of these membranes
- Make new studies with new polymers blends such as: polystyrene-amine-propylene)-styrene (SAPS), PEBAX tested with 6FDA-Durene Diamine.
- Nano-particles can have a variety of chemical surface functionalities which can give polymer matrix materials improved or entirely new properties
- Understanding on transport properties mechanisms (influence of the inorganic filler and the interphase of filler-polymer)
- Improve membrane synthesis

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